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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO
09/522,832	03/10/2000	Katsuhisa Sawazaki	PMS 257760	4821

7590 08/06/2003

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EXAMINER	
BAUMEISTER, BRADLEY W	
ART UNIT	PAPER NUMBER
2815	

DATE MAILED: 08/06/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

DK

Office Action Summary	Application No. 09/522,832	Applicant(s) Sawazaki et al.
	Examiner B. William Baumeister	Art Unit 2815

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on *May 12, 2003*.

2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

Disposition of Claims

4) ☒ Claim(s) *1 and 4-17* is/are pending in the application.

4a) Of the above, claim(s) ____ is/are withdrawn from consideration.

5) ☐ Claim(s) ____ is/are allowed.

6) ☒ Claim(s) *1 and 4-17* is/are rejected.

7) ☐ Claim(s) ____ is/are objected to.

8) ☐ Claims ____ are subject to restriction and/or election requirement.

Application Papers

9) ☐ The specification is objected to by the Examiner.

10) ☐ The drawing(s) filed on ____ is/are a) ☐ accepted or b) ☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11) ☐ The proposed drawing correction filed on ____ is: a) ☐ approved b) ☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13) ☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a) ☐ All b) ☐ Some* c) ☐ None of:

1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

*See the attached detailed Office action for a list of the certified copies not received.

14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

a) ☐ The translation of the foreign language provisional application has been received.

15) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s). ____

4) ☐ Interview Summary (PTO-413) Paper No(s). ____

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other:

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

2. Claims 1, 4-6, 15 and 16 are rejected under 35 U.S.C. 102(e) as being anticipated by Nakamura et al. '307. The rejection is based on the reasons set forth in the previous Office Actions which are incorporated hereinto.

3. Claims 9 and 17 are rejected under 35 U.S.C. 102(b) as being anticipated by Nakamura et al. '350. Nakamura teaches GaN-based LEDs and LDs comprising (using the reference numerals of FIG 1) a MQW active layer 14; an n clad 13 which is in contact with the light emitting layer; a first p-type clad/cap 61; a second p-type clad 62 having a larger Al content (or bandgap) than the first clad and formed directly thereon.

a. The first n-clad may be composed of either GaN or InGaN and have a thickness as small as 10 to 30 angstroms (e.g., col. 5, line 7; col. 7, line 10-20; col. 19, lines 62- and claim 8). Various examples employ the specific thickness of 500 angstroms (e.g., Example 11, col. 39) The MQW active layer has InGaN wells, and the barriers may be composed of either GaN or InGaN (e.g., col. 7, lines 45-50; col. 15, lines 25-30; col. 20, lines 38-30; and claim 11 as amended by the Certificate of Correction). As the first n-clad and the barriers may both be composed of GaN,

they are of substantially the same material and have substantially the same bandgap, as set forth in claims 1 and 15, from which claims 9 and 17 rspectively depend.

b. The first p-clad 61 functions to prevent decomposition of the active layer's InGaN quantum wells (col. 8, lines 20-25). As such it functions as "a cap layer." Nakamura further states that it is preferable that this clad/cap be composed of AlGaN--as opposed to GaN (the latter being substantially the same material as the MQW barrier). However, Nakamura explains that the reason for including Al is that AlGaN was easier to p-dope than was GaN, and states that the alternative use of GaN as the clad/cap reduces the emission by 1/3 (col. 8, lines 28-35), indicating that such devices having a GaN clad/cap were actually constructed. Restated, the fact Nakamura '350 teaches that AlGaN is preferable to GaN does not teach away from using GaN for the cap/clad. Rather, the reference teaches that using GaN was known, but that AlGaN is better.

Claim Rejections - 35 USC § 103

4. Claims 8 and 10-14 are rejected under 35 U.S.C. 102(e) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Nakamura '307.

a. The claims are anticipated under the theory that all of the above-cited claims' ranges are either fully encompassed by or significantly overlap with the respective ranges set forth by Nakamura. Specifically:

i. Regarding claim 8, Nakamura discloses that the active layer wells' thicknesses are preferably between 5 and 70 Angstroms and that the barriers' are preferably between 5 and 150 Angstroms (col. 6, lines 45-53).

ii. Regarding claims 10-13, Nakamura discloses that the p-clad (layer 103) has a thickness which is within the range of 100 Angstroms to 2 microns (col. 8, lines 43-55). The barriers and wells of the MQW active layer may be dimensioned such that the device emits wavelengths within the range of 365 nm (UV) to 660 nm (red) (col. 6, lines 35-).

iii. Regarding claim 14, Nakamura discloses that the p-clad 103 is preferably composed of $In_mAl_nGa_{1-m-n}N$ ($0 \leq m \leq 1$, $0<n \leq 1$, $0<m+n \leq 1$) and preferably AlGaN. This formula's range encompasses the claimed range of Al being between 0.1 and 0.14.

b. The claims are alternatively rejected as being obvious over Nakamura due to the present split that exists in the Board of Patent Appeals member's positions on the issue of the anticipation of ranges. (See e.g., Ex parte Lee (BdPatApp&Int) 31 USPQ2d 1105 (1993).)

i. The claimed range limitations relating to the barrier and well thicknesses and the emitted wavelength ranges are fully encompassed by the ranges set forth in Nakamura. Further, it was well known to those of ordinary skill in the art at the time of the invention how the specific wavelength emitted depends on various factors such as the wells' and barriers' respective bandgaps (compositions) and thicknesses, as these factors influence the carriers' allowed states in the wells and therefore the MQW's effective bandgap. It was also well known how the respective lattice constants associated the particular materials affect the ability to grow heterojunction

superlattices and the resultant strains which, in turn, may further influence the MQW's effective bandgap.

ii. Regarding the Al concentration of the p-AlGaN clad (claim 14), as was stated above, the claimed range was fully encompassed by the range set forth in Nakamura. Further, it was well known to the skilled artisan that increasing the Al content increases the effective bandgap and therefore the effective carrier confinement, but simultaneously increases the voltage requirements.

iii. Regarding thicknesses of the p-clad, the 100A - 2 micron range disclosed by Nakamura fully encompasses the 240-360 angstrom and 120-300 angstrom ranges set forth in the green and blue emitters of claims 11 and 13, respectively, as well as the broader range set forth in the green emitter of claim 10, and it substantially overlaps all but the lowest end of the blue emitter's broader range set forth in claim 12. Further, in addition to increasing the associated manufacturing costs, Nakamura teaches that increasing the clad's thickness decreases the threshold current density (compare examples 9 and 10).

iv. Restated, even if the encompassing and overlapping ranges of Nakamura should be interpreted as not anticipating these claims, the claims' ranges do not produce any novel or unexpected results but rather relate to factors that were previously known and well understood by those skilled in the art at the time of the invention, and as such, merely constitute non-obvious design optimizations. *See e.g., In re Luck* 177 USPQ 523 (CCPA), holding that

routine testing to ascertain the optimum amounts or the most favorable proportions of a compound to achieve its recognized effect would lie within the ambit of ordinary skill in the art.

5. Claim 7 is rejected under 35 U.S.C. 102(e) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Nakamura '307 as applied to the claims above. Claim 7 further recites that both the clad and the barrier are specifically composed of GaN.

a. Nakamura expressly states that the barrier layers of the MQB active region 16 may be composed of GaN (col. 6, line 29). While Nakamura states that it is *preferable* that layer 201 is formed of an aluminum-containing nitride (AlGaN) (col. 10), the disclosure is not so limited. Rather, the reference also expressly states that the tunnel/barrier "layer 201 ... is formed of a nitride semiconductor layer having a band gap energy larger than that of the active layer 16 (more strictly, its well layer)" (col. 10, lines 10-); and it expressly states that layer 201 "has a band gap energy which is larger than that of the active layer by 0.01 - 4.05 eV" (e.g., col. 4, lines 20-21). Further, the bandgap difference between the GaN-based active layer's barriers and wells would necessarily be greater than 0.01 eV; otherwise the active region would not be a superlattice, but would instead be a bulk semiconductor region. Restated, Nakamura's teaching that the tunnel/barrier layer 201 can have a bandgap that is anywhere from 0.01 to 4.05 eV greater than that of the well (which, in turn, is less than that of either the effective or barrier layers' bandgaps), is a teaching that the tunnel/barrier can have a band-gap energy that is either less than, the same as, or greater than that of the active layer's GaN barrier. Moreover, this teaching that the

bandgap of the tunnel/barrier may be the same as that of the active region's barriers, is merely another way of saying that the two layers are composed of the same material; e.g., GaN.

b. Accordingly, since Nakamura teaches that active layer barrier may be GaN and the tunnel/barrier may be made of any bandgap(/composition) within a range that includes GaN, Nakamura anticipates the claim.

c. Alternatively, assuming arguendo that Nakamura must be interpreted so narrowly such that the disclosure of the range is not a disclosure (that the tunnel/barrier may also be composed of GaN) of sufficient particularity as to constitute a data point that would serve as the basis for a 102 anticipation rejection, the claim would nonetheless be obvious over Nakamura. This is because changing the bandgap(/composition) of the tunnel/barrier does not produce any unexpected results. Rather, such changes produce well understood and expected results: as the bandgap increases (as more Al is added to GaN), the tunnel/barrier becomes progressively more efficient in preventing carrier overflow, and the injection efficiency decreases somewhat relative to if no tunnel/barrier was present (because the tunneling probability is necessarily less than 1 and increasing the tunnel/barrier bandgap increases the proportion of carriers that are injected by tunneling). Conversely, as the bandgap decreases, (as the Al is decreased or as more In is added to GaN), the injection efficiency increases, but the tunnel/barrier becomes progressively less efficient in preventing carrier overflow from the opposite side of the active region. Also, increasing the thickness of a tunnel/barrier of any given bandgap decreases the tunneling probability.

d. Accordingly, since Nakamura teaches that active layer barrier may be GaN and the tunnel/barrier may be made of any bandgap/composition within a range that includes GaN, it would have been obvious to one of ordinary skill in the art at the time of the invention to make both the active region's barriers and the tunnel/barrier of GaN because this particular combination is within the range of possibilities disclosed by Nakamura, and one of ordinary skill would have been motivated to choose this particular combination depending only upon conventional and well understood considerations such as the desired light-emission wavelength of the MQB and the desired balance of the tradeoff between injection efficiency and carrier overflow of the particular application; or for various other reasons such as (1) because binary compounds (i.e., GaN) are more stable and easier to form than tertiary compounds (e.g., AlGaN or InGaN); or (2) for considerations of better lattice-matching of the tunnel/barrier to the adjacent MQB barrier since GaN has a lattice constant that is closer to the InGaN compositions than does any of the AlGaN compositions.

Response to Arguments

6. Applicant's arguments filed 5/12/2003 have been fully considered but they are not persuasive for the reasons set forth previously, hereinabove and hereinbelow.

a. Applicant has argued that making the tunnel/clad composition the same as that of the MQW barrier would improve the color purity and that Nakamura '307 does not recognize this advantage. However, the fact that applicant has recognized another advantage which would flow

naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985).

Moreover, the fact that it was envisioned by the inventors of Nakamura '307 that GaN in particular could be employed GaN for both the barriers and the n-type clad is evidenced by the fact that the inventors of Nakamura '307 actually did employ GaN for both of these layers in Nakamura '350.

Conclusion

7. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL.** See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

INFORMATION ON HOW TO CONTACT THE USPTO

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to the examiner, **B. William Baumeister,** at **(703) 306-9165.** The examiner can normally be reached Monday through Friday, 8:30 a.m. to 5:00 p.m. If the Examiner is not available, the Examiner's supervisor, Mr. Eddie Lee, can be reached at (703) 308-1690. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956.

B. WILLIAM BAUMEISTER
PRIMARY EXAMINER

B. William Baumeister

Primary Examiner, Art Unit 2815

July 26, 2003